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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/871,883	06/01/2001	Birendra N. Agarwala	BUR920000215US1	2063

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EXAMINER
WARREN, MATTHEW E

ART UNIT	PAPER NUMBER
2815	

DATE MAILED: 01/13/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/871,883	AGARWALA ET AL.	
	Examiner	Art Unit	
	Matthew E. Warren	2815	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 October 2002* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-4,6-13,15-20,22-25 and 27-35* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-4,6-13,15-20,22-25 and 27-35* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☒ The proposed drawing correction filed on *15 October 2002* is: a)☒ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

This Office Action is in response to the Amendment filed on October 15, 2003.

Drawings

The proposed drawing correction and/or the proposed substitute sheets of drawings, filed on October 15, 2002 have been approved. A proper drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The correction to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-4, 6-13, 15-20, 22-25, 27-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farrar (US 6,376,370 B1) in view of Havemann (US 6,156,651).

Farrar shows (fig. 3K) an interconnect structure comprising a lower level wire in a dielectric layer having a side and bottom, the lower level wiring comprising a core conductor (307B and 320) and a lower conductive liner (306B and 314). The lower level wire also has integral extensions (part above 307), the extensions having a side and

bottom, wherein the lower level wire and extensions also comprise the lower core conductor (320) and the lower conductive liner (314). The liner is formed on the side and bottom of the lower level wire and the extension. The lower conductive liner has an upper edge having an inner surface, an outer surface, and a top surface, the top surface of the upper edge substantially coplanar with a top surface of the dielectric layer. The interconnect also comprises an upper level wire (330) having a side and bottom and a via integrally formed in the bottom of the upper level wire. The via also has a side and bottom. The upper level wire and via comprise an upper core conductor (344) and an upper conductive liner (334), which is formed on the side and bottom of the upper level wire and on the side and bottom of the via. The upper conductive liner on the bottom of the via is in contact with the lower core conductor and also in contact with the lower conductive liner in a liner-to-liner contact region. The lower level wire is formed in a lower level dielectric (302 and 308) and the upper level wire is formed in an upper level dielectric (324). The upper and lower core conductors comprise copper (col. 17, lines 20-39) and the upper and lower conductive liners comprise tantalum nitride (col. 18, lines 22-33). The lower conductive liner includes an upper edge having an inner surface, an outer surface, and a top surface (top of layer 381 and 382) and the upper conductive line on the bottom of the via contacts one of the top surfaces to form the liner-to-liner contact region. The liner-to-liner contact region also comprises a first portion co-extensive with the lower conductive liner on a portion of a first side (top surface of liner 314) of the lower level wire under the via (see the interface 319 between 383 and 381). The first and second dielectrics consist of silicon oxide (col. 17, lines 39-

47). Farrar shows all of the elements of the claims except a portion of the bottom of the upper level wire extending below a top surface of the lower wire level, the upper conductive liner in contact with the inner or outer surface of the upper edge of the conductive liner, and the second and third portions of the liner-to-liner contact region being coextensive with the lower conductive liner. Havemann shows (fig. 3G) an interconnect structure in which a lower level wire has a lower core conductor (39) and a lower conductive liner (36). An upper level wire has an upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact region. A portion of the bottom of the upper level wire extends below a top surface of the lower wire level. The upper conductive liner is in contact the lower core conductor and also in contact with the inner surface of the outer surface or both surfaces of the upper edge of the conductive liner (see how the upper liner 48 overlaps the upper edge and sides of lower liner 36). The liner-to-liner contact region also comprises a second portion (overlap portion of liner 48) co-extensive with the lower liner on a portion of a second side (outer portion of liner 36) of the lower level wire and a third portion (overlap portion of liner 48 in the hole) co-extensive with the lower conductive liner on an end (inner portion of the liner 36) of the lower level wire, each portion being under the upper level wire. With this configuration, the interconnect can be formed without mechanical defects (abstract). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the liner-to-liner contact region of Farrar by adding the second and third coextensive portions as taught by Havemann to form a contact without mechanical defects.

With respect to the limitations concerning the damascene process of forming the wires, a "product by process" claim is directed to the product per se, no matter how actually made, In re Hirao, **190 USPQ 15 at 17**(footnote 3). See also in re Brown, **173 USPQ 685**: In re Luck, **177 USPQ 523**; In re Fessmann, **180 USPQ 324**: In re Avery, **186 USPQ 116** in re Wertheim, **191 USPQ 90** (**209 USPQ 254** does not deal with this issue); and In re Marosi et al, **218 USPQ 289** final product per se which must be determined in a "product by, all of" claim, and not the patentability of the process, and that an old or obvious product, whether claimed in "product by process" claims or not. Note that Applicant has the burden of proof in such cases, as the above case law makes clear. "Even though product-by- process claims are limited by and defined by the process, determination of patentability is based upon the product itself. The patentability of a product does not depend on its method of production. If the product in product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product is made by a different process." In re Thorpe, 227 USPQ 964, 966 (Fed. Cir. 1985)(citations omitted).

Claims 30-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farrar (US 6,376,370 B1) in view of Otsuka et al. (US 6,373,136 B2).

Farrar shows (fig. 3K) an interconnect structure comprising a lower level wire having a side and bottom, the lower level wiring comprising a core conductor (307B and 320) and a lower conductive liner (306B and 314). The liner is formed on the side and bottom of the lower level wire. The interconnect also comprises an upper level wire

(330) having a side and bottom and a via integrally formed in the bottom of the upper level wire. The via also has a side and bottom. The upper level wire and via comprise an upper core conductor (344) and an upper conductive liner (334), which is formed on the side and bottom of the upper level wire and on the side and bottom of the via. The upper conductive liner on the bottom of the via is in contact with the lower core conductor and also in contact with the lower conductive liner in a liner-to-liner contact region. The lower level wire is formed in a lower level dielectric (302 and 308) and the upper level wire is formed in an upper level dielectric (324). Farrar shows all of the elements of the claims except the dielectric pillars formed in the lower level wire. Otsuka et al. discloses (col. 12, lines 30-52) insulating pillars formed in a level of wiring. With such a configuration a highly reliable damascene structure is formed (col. 2, lines 50-52). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the lower interconnect wiring level of Farrar by adding dielectric pillars as taught by Otsuka et al. to form a highly reliable damascene wiring structure.

Claims 34 and 35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farrar (US 6,376,370 B1) in view of Otsuka et al. (US 6,373,136 B2) as applied to claims 31 and 33 above, and further in view of Havemann (US 6,156,651).

Farrar and Otsuka et al. show all of the elements of the claims except the second and third portions of the liner-to-liner contact region being coextensive with the lower conductive liner. Havemann shows (fig. 3G) an interconnect structure in which a lower

level wire has a lower core conductor (39) and a lower conductive liner (36). An upper level wire has a upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact region. The liner-to-liner contact region also comprises a second portion (overlap portion of liner 48) co-extensive with the lower liner on a portion of a second side (outer portion of liner 36) of the lower level wire and a third portion (overlap portion of liner 48 in the hole) co-extensive with the lower conductive liner on an end (inner portion of the liner 36) of the lower level wire, each portion being under the upper level wire. With this configuration, the interconnect can be formed without mechanical defects (abstract). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the liner-to-liner contact region of Farrar and Otsuka by adding the second and third coextensive portions as taught by Havemann to form a contact without mechanical defects.

Response to Arguments

Applicant's arguments with respect to claims 1-4, 6-13, 15-20, 22-25, 27-29 have been considered but are moot in view of the new ground(s) of rejection.

Applicant's arguments filed with respect to claims 30 and 31 have been fully considered but they are not persuasive. The applicant primarily argues that Farrar in view of Otsuka et al. does not teach every feature of the claims, specifically that Farrar and Otsuka do not teach one or more dielectric pillars formed in said lower level wire on the sides of the conductive liner and the upper conductive liner in contact with the lower

conductive liner on the sides of the dielectric pillars in a liner-to-liner contact region. The examiner contends that Farrar and Otsuka show all of the elements of the claims. Farrar, disclosing the various wiring levels each having conductive cores and liners, was only deficient in disclosing dielectric pillars formed in the wiring level. Otsuka was cited to show that conductive pillars were formed in wiring levels to improve the structural integrity. Furthermore, as seen in figure 13C of Otsuka, the dielectric pillars (P) are formed next to conductive wiring material (10). Therefore one of ordinary skill in the art, wishing to improve the structural integrity of the semiconductor would add the conductive pillars of Otsuka and form them next to the wiring levels having a core and a liner of Farrar. Otsuka thus cures the deficiency of Farrar and shows motivation for the improvement. The 103 rejection is still proper and this action is final.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any

extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew E. Warren whose telephone number is (703) 305-0760. The examiner can normally be reached on Mon-Thurs, and alternating Fri, 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie Lee can be reached on (703) 308-1690. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 305-3432 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

MEW
January 9, 2003